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(54) **UTILIZATION OF A MOBILE AGRICULTURAL WEIGHING SYSTEM TO MONITOR AND STORE ANCILLARY OPERATIONAL DATA FOR DIAGNOSTIC PURPOSES ON TRAILED AND TRUCK-MOUNTED EQUIPMENT**

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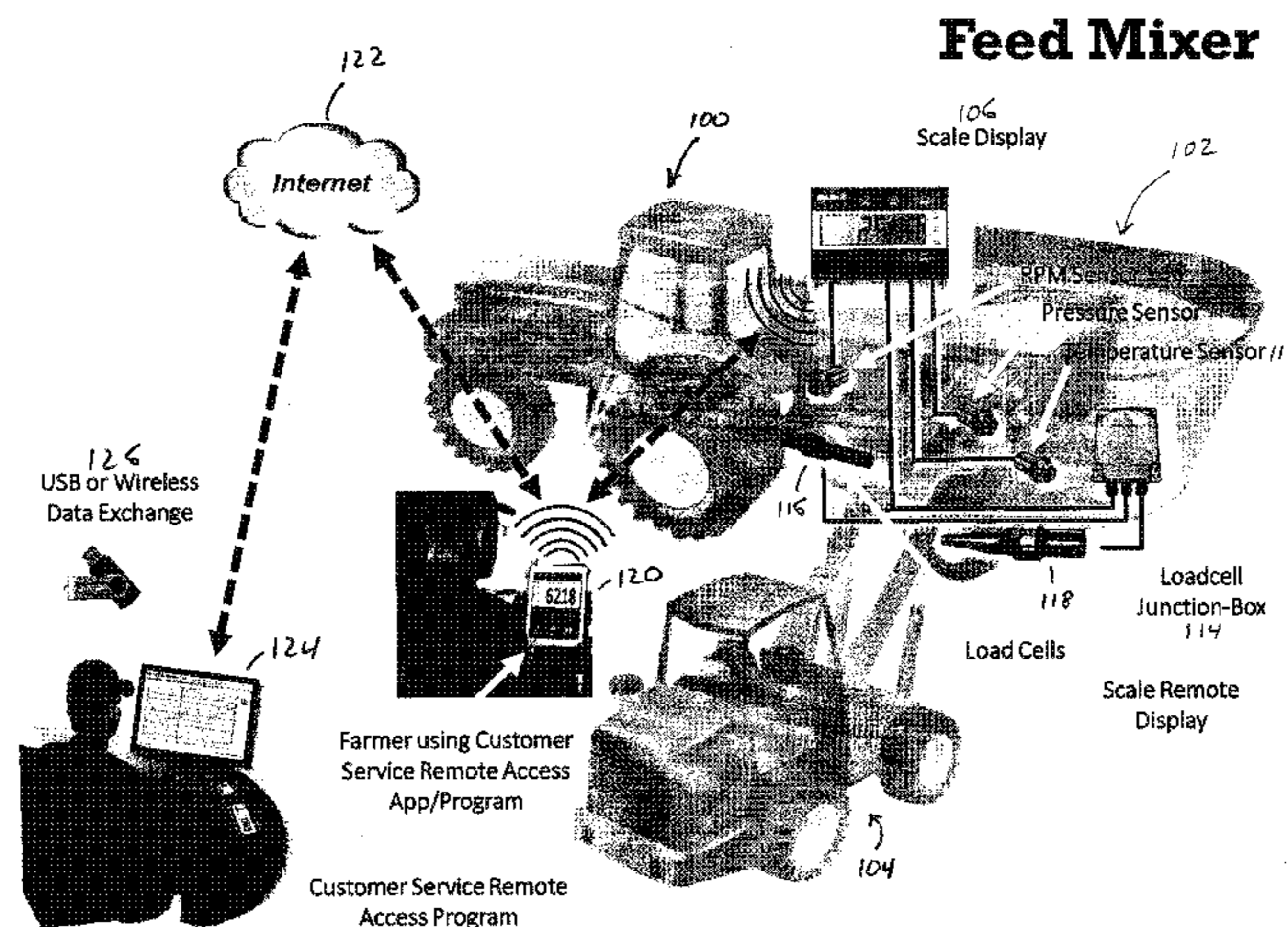
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(57) **ABSTRACT**

A method of operation of a machine control indicator located on a first machine includes the step of monitoring operational parameters of a second machine operationally associated with a first machine. Each of the operational parameters is associated with a common clock of the machine control indicator. The operational parameters are stored in a memory of the machine control indicator with a date and time stamp based on the common clock. The operational parameters are transmitted along with the date and time stamp to a user device separate from the first machine and the second machine. In one embodiment, the operational parameters comprise one or more of a weight value, a rotation value, a revolutions per minute value, a peak weight value, a gearbox temperature value, and a hydraulic pressure value.

13 Claims, 9 Drawing Sheets



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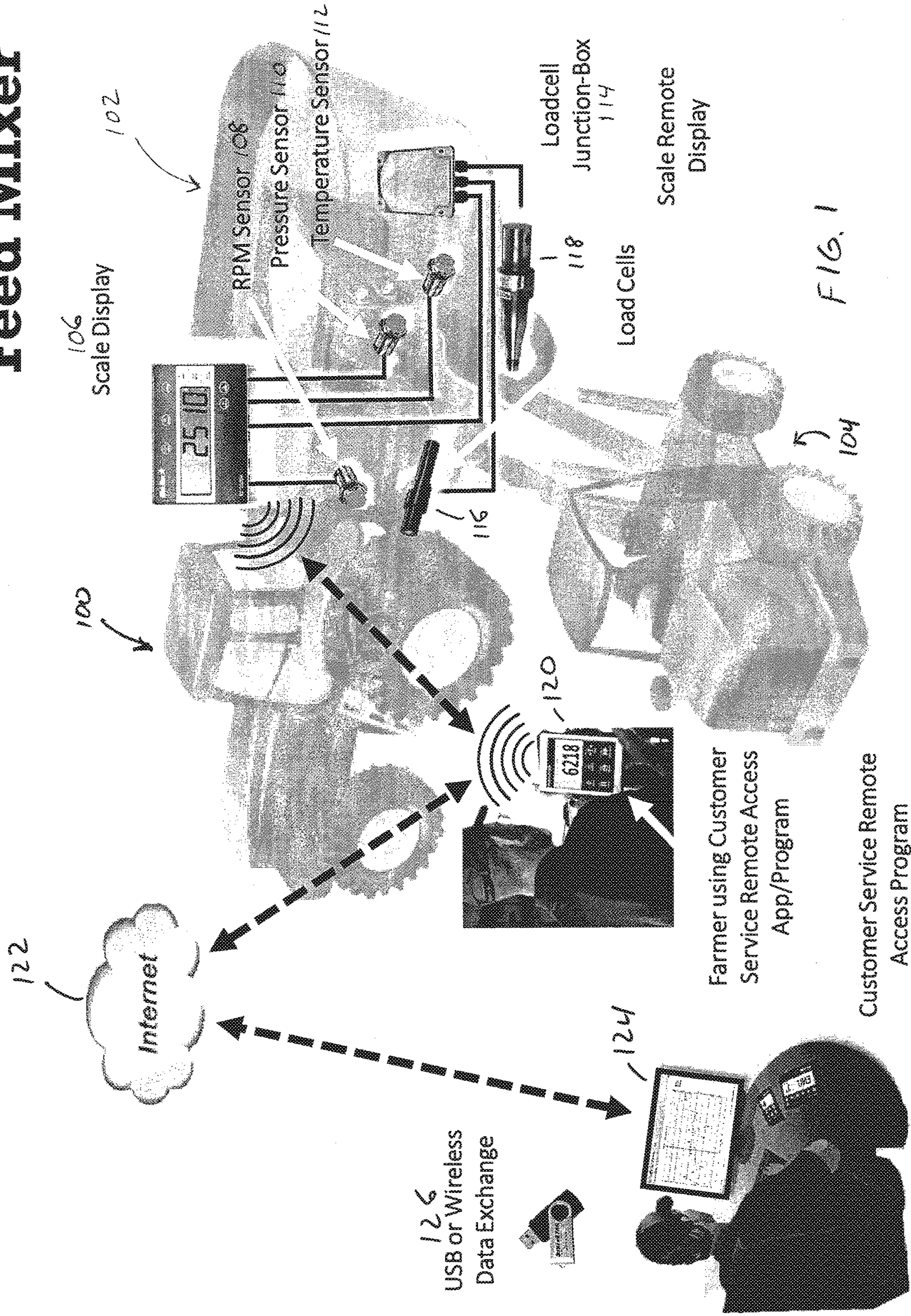
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Feed Mixer



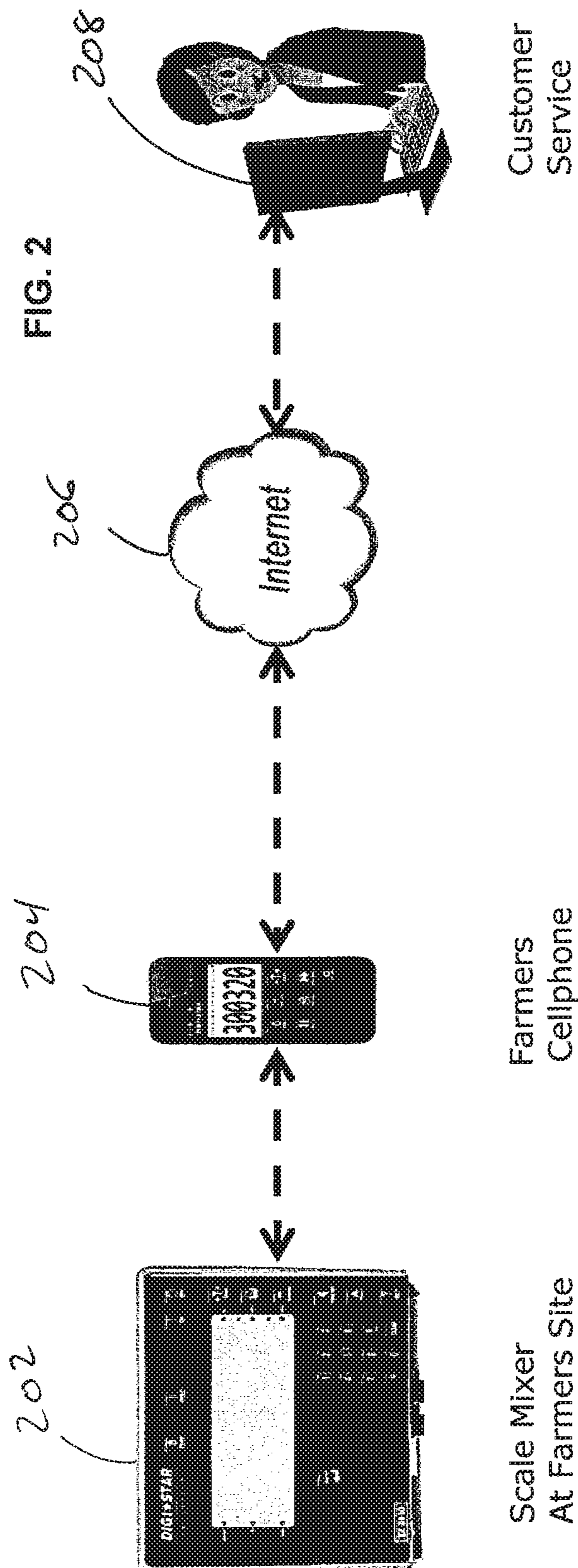
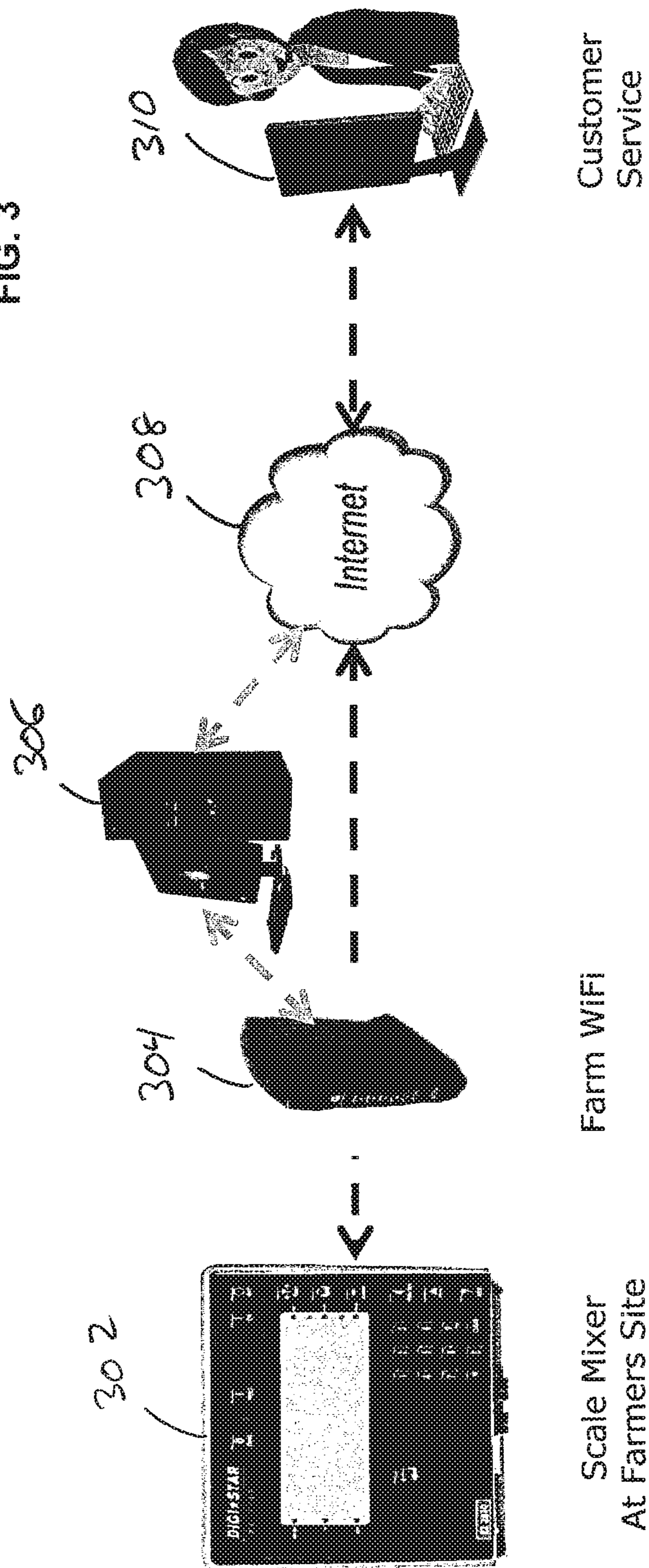
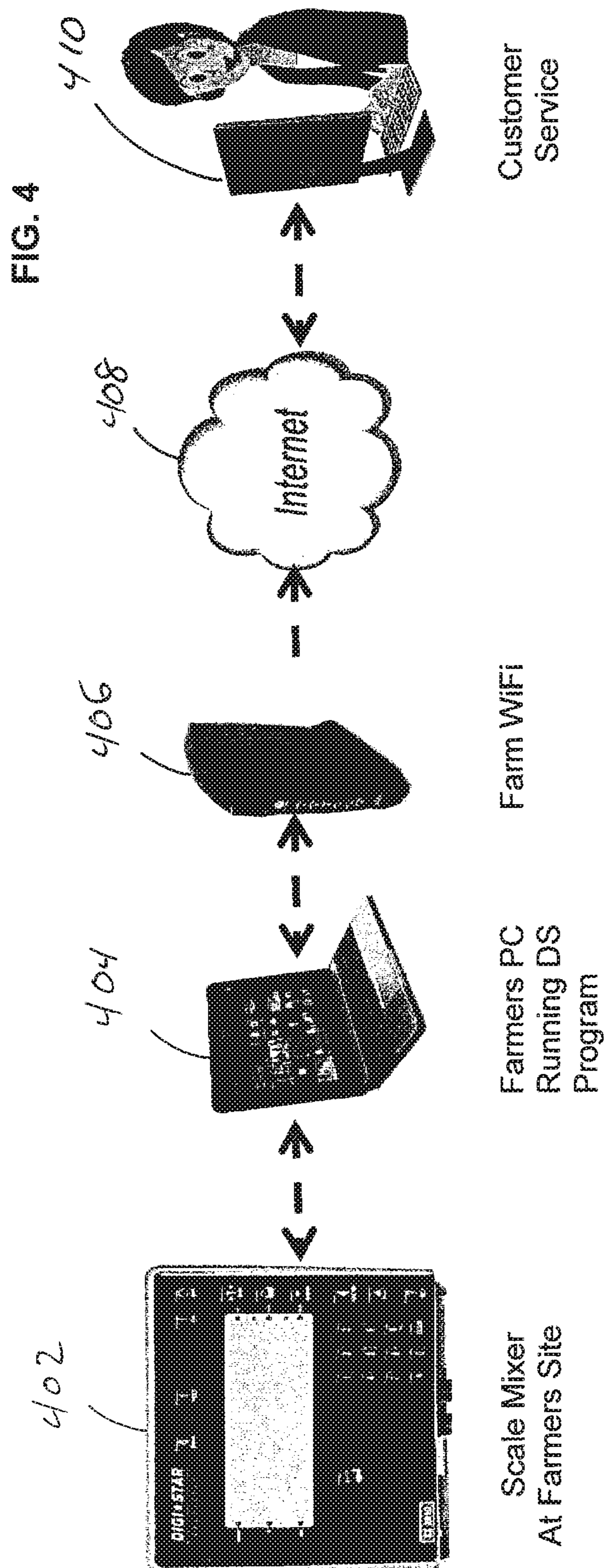


FIG. 3





Mixing Profile

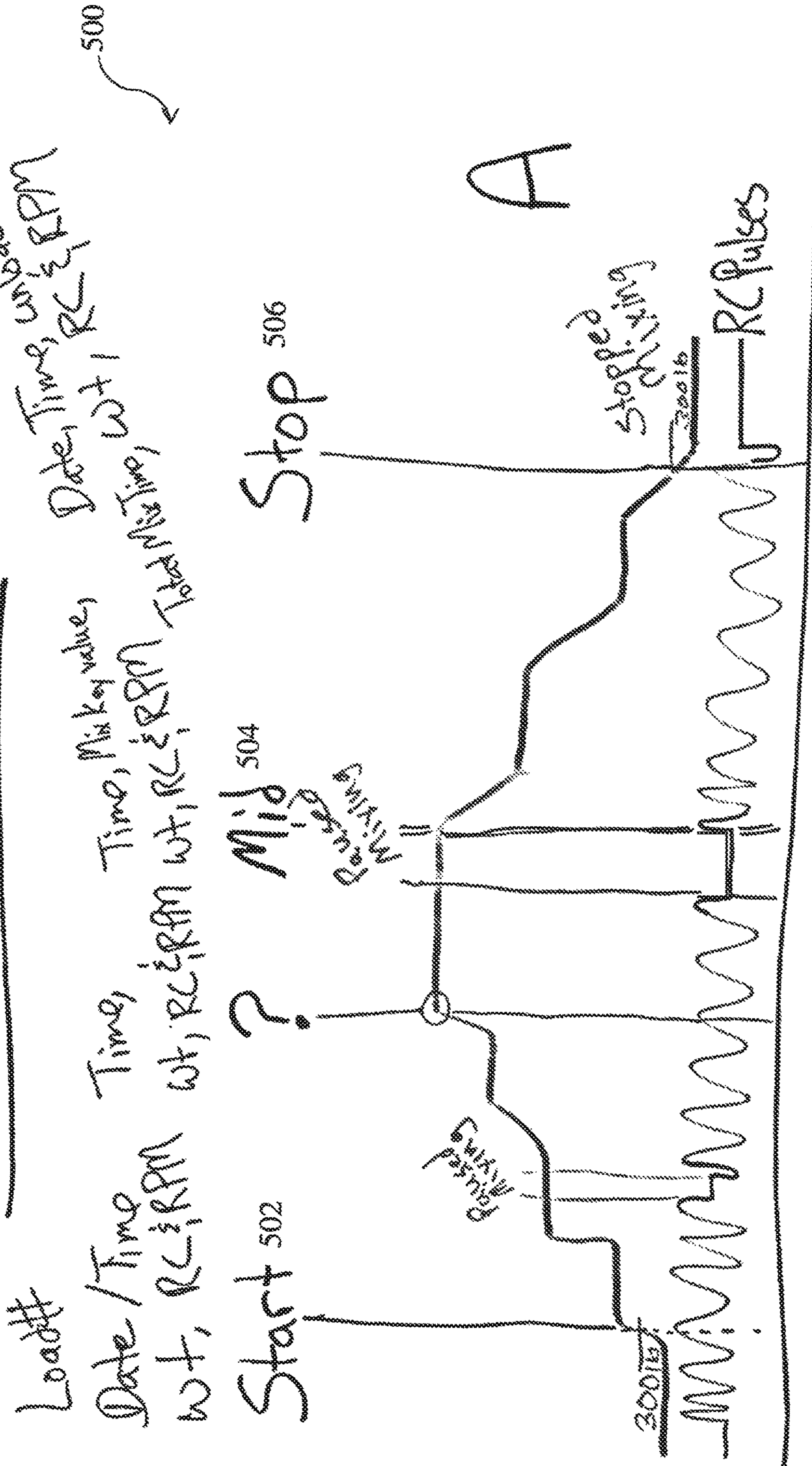


FIG. 5

Mixing Profile

Date/Time, wt, RC, RPM

Load#
 Date / Time
 wt, RC, RPM
 Start 502
 ?
 Mid 504
 Stop 506

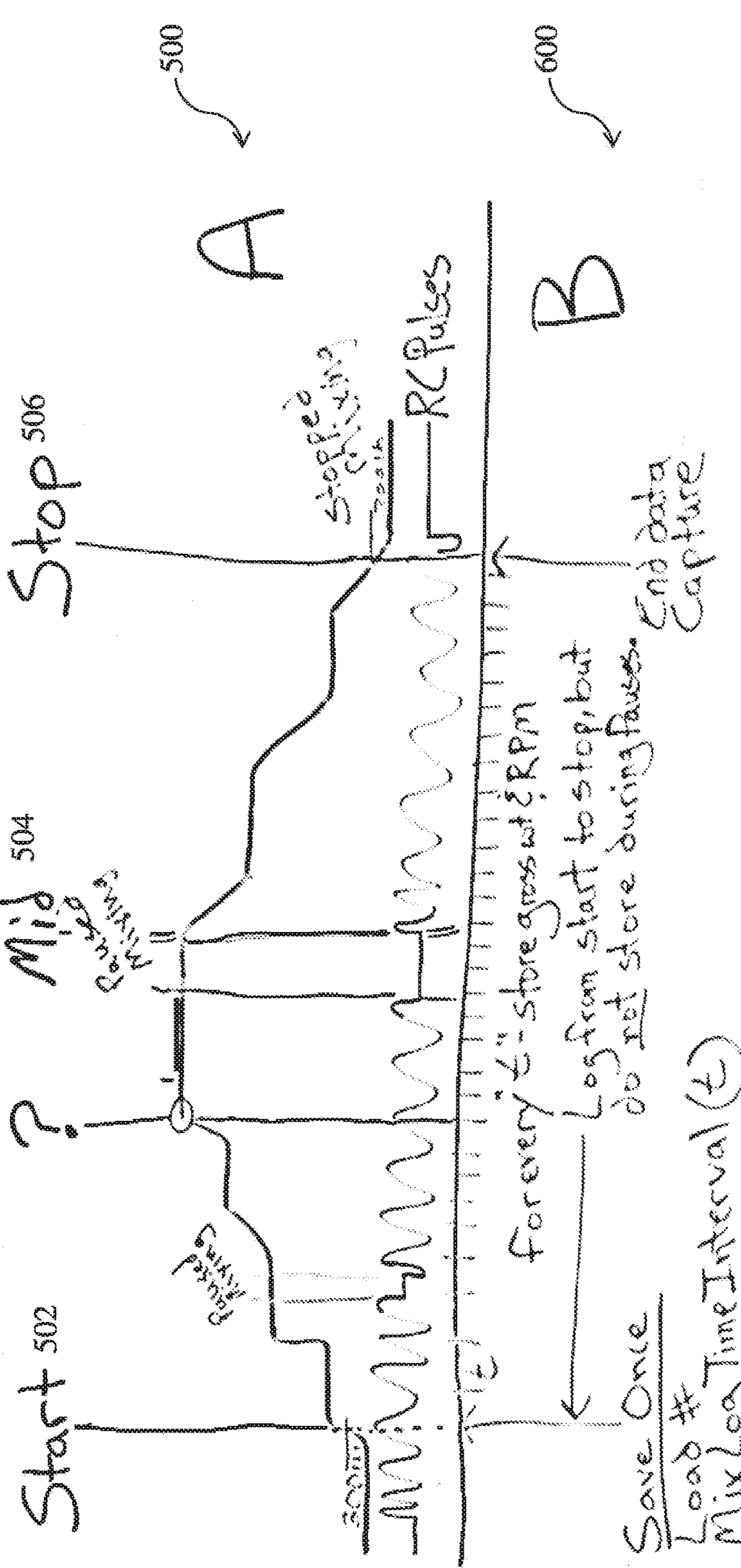


FIG. 6

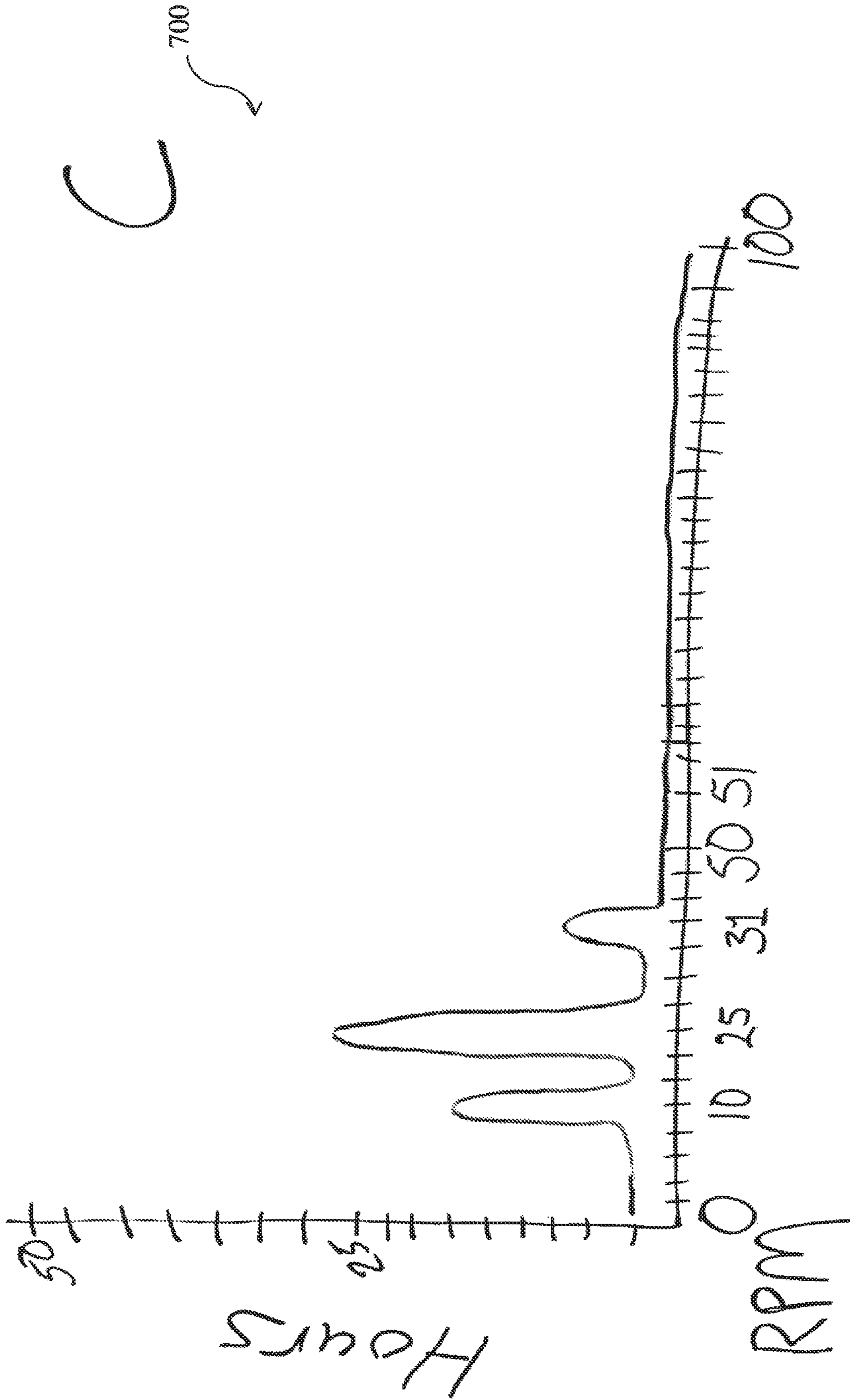


FIG. 7



FIG. 8

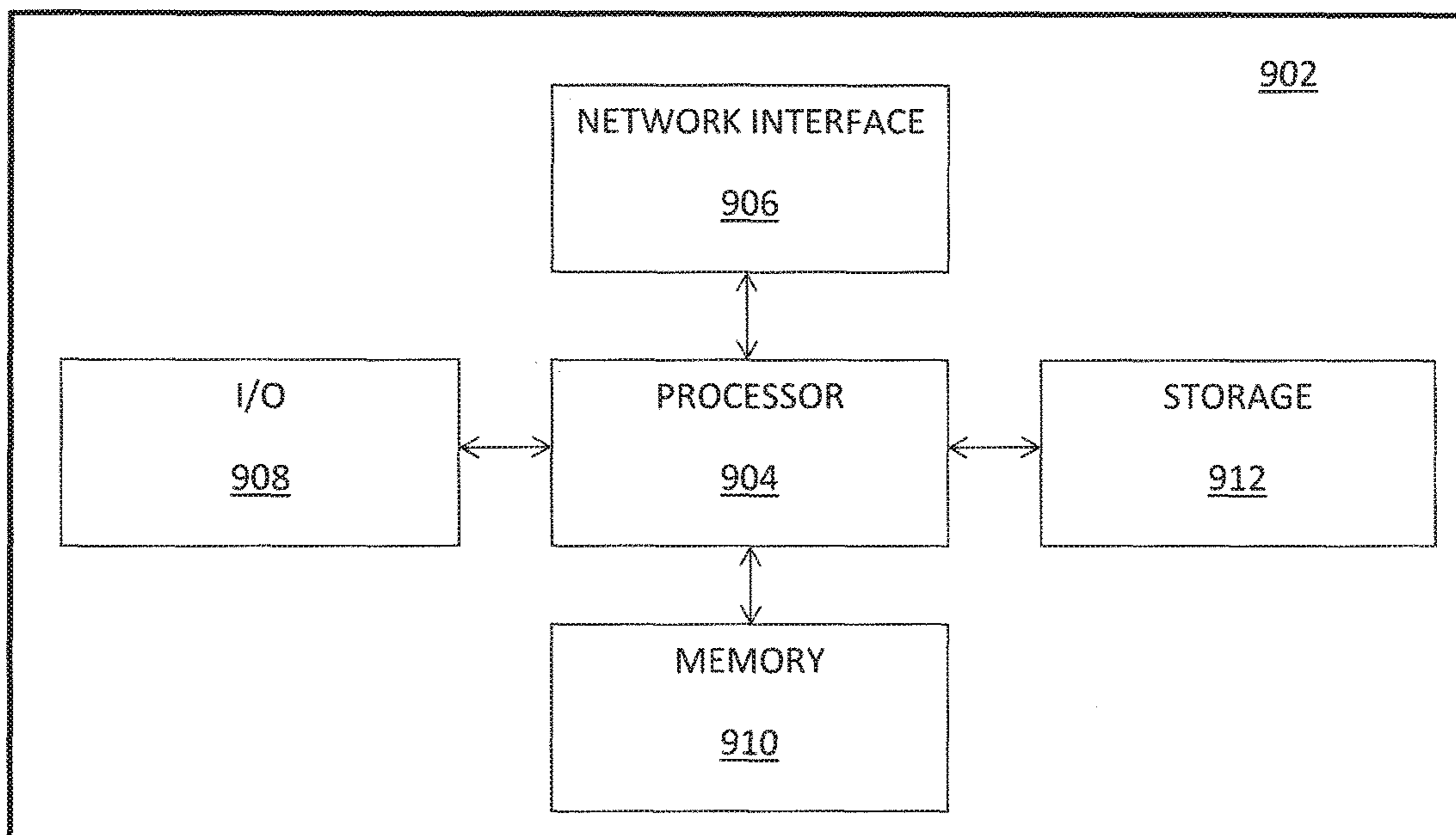


FIG. 9

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**UTILIZATION OF A MOBILE
AGRICULTURAL WEIGHING SYSTEM TO
MONITOR AND STORE ANCILLARY
OPERATIONAL DATA FOR DIAGNOSTIC
PURPOSES ON TRAILED AND
TRUCK-MOUNTED EQUIPMENT**

The present application claims priority to U.S. Provisional Application No. 61/165,547 filed May 22, 2015, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

Agricultural machines may include various controls and sensors in order to control operation of the various aspects of the machines. An agricultural machine indicator (also referred to as an "indicator") provides an interface through which a user can perform operations such as modifying control parameters, options and/or settings and accessing machine information such as operating conditions. The large numbers of settings and options indicators offer provide benefits and challenges to users (also referred to as end users). On the positive side indicators can be customized to meet a wide variety of needs.

On the negative side when settings and options are setup incorrectly it can be challenging for the user, the Original Equipment Manufacturer (OEM) Dealer, the OEM, and the indicator manufacturer (also referred to as the "indicator provider") to find the setting, or settings, that prevent the indicator from operating correctly.

This is especially frustrating when Tech Support from the indicator provider or the OEM have difficulties due to; language, miscommunication, and a lack of understanding from the user.

SUMMARY

Remote access to a machine control indicator (using a smart device and/or farm network), significantly increases the ability of the OEMs and indicator providers to support products that are becoming increasingly complex. Problems and issues can be taken care of in less time which increases the efficiency of indicator provider and OEM Support Departments. This is especially true in International Markets where language barriers that result in travel time for field service calls can be eliminated. New indicator setup and customization can occur quickly and with less confusion and mistakes.

In addition, the functionality described herein provides OEMs, especially Mixer OEMs, with the ability to more closely monitor their equipment by providing access to an Hours of Use and a Maintenance Message functionality.

The need to provide improved methods of remotely accessing indicators to correct settings and options will only grow as a greater proportion of indicators are used with advanced settings for wireless (such as Wi-Fi) and Data Acquisition and Data Exchange.

Capabilities for software updates add an additional element to the need for remote access.

In one embodiment, a system and method provides a means to connect via radio or directly with the indicator that provides a means to access and setup the indicator as well as a means to update the software on the indicator. Utilization of a Mobile Agricultural Weighing System to Monitor and Store Ancillary Operational Data for Diagnostic Purposes on Trailed and Truck-Mounted Equipment

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In one embodiment, a method and system for monitoring trailed and truck-mounted agricultural equipment uses a machine control indicator. The method and system provides the ability to transfer machine operation data to diagnose any problems and help the operator use the machine to obtain the best machine performance possible.

In one embodiment, a machine control indicator system (also referred to as a scale indicator system) provides monitoring and recording capability for operational data on: system settings, weight, rotation, revolutions per minute, peak weights, gearbox temperatures, hydraulic pressures, and the minimum and maximum limits of this data, on mobile agricultural Seed Tenders, Planters, Seed Drills, Air Seeders, Grain Carts, or Feed Mixers. This system utilizes wired, wireless, or data transfer devices such as USB Drives for the transfer of this data. The system allows for the transfer of data required to diagnose drive and weighing system operation from the machine's location to another location via email or wireless communication (such as Wi-Fi), thus allowing for real-time user viewable data related to the operation of the machinery.

Existing methods and systems utilize multiple systems and devices to accomplish the recording of the above noted operational performance data. Machines must be equipped with separate systems for individually monitoring: weight, operating speeds, gearbox temperatures, and hydraulic system pressures. The result is that Operator, OEM Dealer Support Technician, or Manufacturer must compare data from multiple sources to determine correlations and root causes that result in incorrect operation or equipment failures. Due to inherent variances in operational data collection it can therefore be difficult to properly determine the root causes and effects.

The method and system described herein employs the concept of utilizing the electronics of the scale system to provide additional monitoring and data collection of machine operational parameters related to: weight, rotation (On/Off), revolutions per minute, peak weights, temperatures of gearboxes, and temperatures and pressures of hydraulic systems, and the minimum and maximum limits for each of these parameters, with the date and time at which each event is recorded.

The Operator or Service Technician can download the recorded data using a USB Memory Device, Wired Cable Connection via Serial or CANBUS Communication, or wireless communication, to a computer or smart device equipped with a program or application that will display both the raw data in tabular form and with a graphical means based on a timeline.

The graphical display of the data allows the viewer to easily determine when an event, or events, results in a concurrent effect on another component or the machine operating system as a whole.

A method of operation of a machine control indicator located on a first machine, according to one embodiment, includes the step of monitoring operational parameters of a second machine operationally associated with a first machine. Each of the operational parameters is associated with a common clock of the machine control indicator. The operational parameters are stored in a memory of the machine control indicator with a date and time stamp based on the common clock. The operational parameters are transmitted along with the date and time stamp to a user device separate from the first machine and the second machine. In one embodiment, the operational parameters comprise one or more of a weight value, a rotation value, a revolutions per minute value, a peak weight value, a gearbox temperature

value, and a hydraulic pressure value. The operational parameters, in one embodiment, are received from sensors located on the second machine. In one embodiment, the data from the user device pertaining to operation of one of the first machine and the second machine is received. Actuators associated with one of the first machine and the second machine are controlled based on the data from the user device.

In one embodiment, the monitoring comprises receiving data from sensors located on one of the first machine and the second machine. The second machine trails the first machine in one embodiment and can be one of a seed tender, a planter, a seed drill, an air seeder, a grain cart, and a feed mixer. In one embodiment, the operational parameters are transmitted to a customer service device via the user device.

In one embodiment, a method of operation of a machine control indicator includes the step of monitoring operational parameters of an agricultural machine. Each of the operational parameters is associated with a common clock of the machine control indicator. The operational parameters are stored in a memory of the machine control indicator with a date and time stamp based on the common clock. The operational parameters are transmitted along with the date and time stamp to a user device separate from the agricultural machine.

Diagnostic Monitoring and Recording of Hydraulic System Components on Agricultural Mixers

In one embodiment, an Animal Feed Mixer (Dairy or Beef) Scale indicator system records Feed Mixer Operating Speed along with the operating temperatures and hydraulic & lube oil pressures of the mixer gearboxes and hydraulic drive system and notifies the operator and records the temperature or pressures, along with the weight, date, and time, when limits have been exceeded.

The system records when the temperature and/or pressures of the mixer gearbox(s) and hydrostatic drive system monitored by the scale indicator system exceed limits along with the weight of material in the mixer, and the operating speed of the main mixer auger, rotor, or reel (as noted above), with the time and date. The system can also display a warning message that the temperature or pressure limit has been exceeded.

Agricultural Feed Mixers, whether mounted on a trailer frame or truck chassis do not usually have an electronic system that will display warnings regarding the operating temperatures and pressures of the system being out of norm (like the oil pressure and temperature warning lights on an automobile). Therefore a need exists to display warnings in order to help protect the expensive components of the feed mixer's drive system.

In addition there is a need to record both, when the warnings are displayed, and how many times the warnings have been displayed. This information can be used by the machine owner to perform checks on his employee/operators, and by the OEM Dealer and Manufacturer to aid in failure cause and warrantee investigations.

Failure to heed the warnings can result in failures to gearboxes, hydraulic pumps, and/or hydraulic motors that are expensive to repair or replace.

Furthermore it is useful to record the warning information with other mixer operational parameters that are happening at the same time including the mixer operating speed and the weight of material inside the mixer.

The system described herein consists of a machine control indicator that also includes sensor inputs for rotational speed, pressure, and temperature.

The indicator is programmed with the required temperature and pressure limits (high, low, or both) that a particular machine is designed to operate within. These programming settings are secured by a "factory" access code that is not available to the end user.

When the limits of temperature or pressure are exceeded the indicator can display a "High Oil Temperature", "Low Oil Pressure", or "High Oil Pressure" warning on the display of the indicator in lieu of the weight information that is normally displayed. To clear the warning the operator will need to press a specific key to acknowledge.

The indicator can, at the same time as the above, record the following background information in an even record regarding the warning: Date, Time, Revolutions per Minute, Weight in Mixer, and the Temperature or Pressure.

The event records are retained, in one embodiment, in non-volatile memory which cannot be deleted without a factory access code and a special key sequence. The event records can be downloaded through the indicator's USB port. Recording Mixer Rotation Rate Along with Weight of Feed and Date and Time

An Animal Feed Mixer (Dairy or Beef) Scale system that records Feed Mixer Operating Speed along with the Weight of Feed in the mixer over Time (with Date) is described herein.

The system can record the Rotations per Minute of the primary mixing auger(s), rotor, or reel of an agricultural Feed Mixer along with the weight of feed in the mixer with date & time.

When mixing feed for dairy and beef animals there 3 steps necessary to achieve a good mix. These are:

a. Loading the proper amount (by weight) of each feed ingredient: Corn Silage, Haylage, Dry Hay, Soy Meal, Cotton Seed, etc.

b. Processing individual, or combined ingredients, to achieve the correct ingredient size. Feed ingredients from large round and large square bales of hay or baleage take time inside the mixer to be processed to the correct length. These ingredients are added to the mixer first so that the mixer can process the bale (break down and cut up the material). The time the mixer is allowed to run with the first ingredient(s), before any other ingredients are added, needs to be monitored and controlled.

c. Once the mixer is completely loaded with all ingredients the total length of time the mixer mixes (actually the number of turns of the mixer) is very important. If the mixer is run for too short of a time the feed in the mixer will not be completely and uniformly mixed. If the mixer is run for too long of a period of time the mixer will over-mix the feed resulting in an over-processed mix with insufficient "length-of-cut" whereby the feed will not stimulate the rumen in the cow and the cow will not efficiently digest the feed.

It is important to note that the "Time" spent mixing is dependent on the speed that the mixer is turning. The mix process is dependent on the number of turns of the mixer, not the time. For example; by careful observation the farmer finds that it takes 4 minutes at 20 rpm to achieve the correct mix. This equals 100 turns of the mixer. If the farmer's father operates the mixer at $\frac{3}{4}$ speed (15 rpm) he will need to run the mixer for an additional minute (5 minutes total) to achieve the same 100 turns of the mixer.

For this reason the speed at which the mixer operates over time is what needs to be measured and recorded in order to know the number of revolutions.

The system consists of:

a. A Scale Indicator that, in addition to weighing, is fitted with a Rotation Counter sensor fitted to a main auger, rotor,

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or reel drive component to both sense that the component is turning and to count the revolutions of the shaft.

b. The Indicator has a Setting to enter the correct ratio between the rotation that the Rotation Counter is sensing and the rotation of the main auger, rotor, or reel. The Indicator uses this ratio to count the rotations per minute that the main auger, rotor, or reel is turning. In one embodiment, this setting is protected by a security access code to prevent tampering with the settings.

c. The Indicator system records both the weight of the individual ingredients and the speed at which the mixer main auger, rotor, or reel is operating at over time (with date). The Indicator records this information at periodic intervals with the interval being adjustable.

The output data from the system can be displayed in a spreadsheet or graph showing Weight and RPM over Time.

From this data an indicator provider and/or the customer can produce a dual line graph which will show Time on the horizontal "X" axis and two "Y" axis where "Y1" records Weight and "Y2" records the Mixer RPM.

With this information it is easy to analyze the process and steps of loading the mixer, mixing the mix, and more as the feed is unloaded.

The concept of recording the Revolutions Per Minute while mixing, and the Total Revolutions that take place to make a mix, of the Feed Mixer is beneficial to the indicator provider, machine provider, and machine user.

By recording this information indicator provider can provide both the end user, and the manufacturer of the mixer, with data and information that is useful and important.

The farm owner/manager can determine if the employees operating the mixer are following instructions and are operating the mixer at the correct speed for each step and for the correct amount of time.

For the OEM manufacturer this info will tell the OEM if; the mixer has been over-spiced, i.e. run at too high of a speed (such that it would cause damage), improper operation resulted in damage that is not warrantable, mixing data that the OEM can use to help train and coach the end user farmer in how to properly operate the mixer.

The system also senses the operating temperatures and hydraulic & lube oil pressures of the mixer gearboxes and hydraulic drive system and notifies the operator and records the temperature or pressures, along with the weight, date, and time, when limits have been exceeded.

Recording the Rotations per Minute of the primary mixing auger(s), rotor, or reel of an agricultural Feed Mixer along with the weight of feed in the mixer with date & time.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts a system for remote indicator access according to one embodiment;

FIG. 2 depicts a system for remote indicator access according to another embodiment;

FIG. 3 depicts a system for remote indicator access according to another embodiment;

FIG. 4 depicts a system for remote indicator access according to another embodiment;

FIG. 5 depicts a mixing profile according to one embodiment;

FIG. 6 depicts mixing profile and a mixing log according to one embodiment;

FIG. 7 depicts a graph illustrating hours a machine is run at various RPMs;

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FIG. 8 depicts a flowchart of a method of operation of a machine control indicator according to one embodiment; and

FIG. 9 depicts a high level block diagram of a computer.

DETAILED DESCRIPTION

FIG. 1 depicts a system for remote indicator access according to one embodiment. As shown in FIG. 1, a tractor **100** has a machine attached. In this case, the machine is a feed mixer **102** for mixing ingredients to be fed to animals. Feed mixer **102** is shown in the process of receiving ingredients from front loader **104**. Tractor **100** has a machine control indicator **106** (also referred to as a scale display or scale indicator) which can be located in the cab of tractor **100** to provide information to a user. Machine control indicator **106** can be mounted in other locations as well such as on feed mixer **102**. Machine control indicator **106** receives inputs from various sensors including rotations per minute (RPM) sensor **108**, pressure sensor **110**, and temperature sensor **112**. Machine control indicator **106** is also in communication with load cell junction box **114** which receives data from load cells **116** and **118** (also referred to as weight sensors) which can be used to provide weight information to indicator **106**. In one embodiment, sensors **108**, **110**, and **112**, and load cell junction box **114** are wired to machine control indicator **106**. In other embodiments, various data can be transmitted from sensors wirelessly to machine control indicator **106**. The data that machine control indicator **106** receives can be referred to as operational parameters or operational performance data. In one embodiment, machine control indicator **106** is also connected to various outputs such as alarms (e.g., 12 volt wired audible alarm).

Machine control indicator **106** is in communication with a user device **120** which can be any electronic device capable of communicating with machine control head **106**. For example, user device **120** can be a smart phone or tablet. In one embodiment, user device **120** receives information from machine control indicator **106** which can then be displayed via an application (also referred to as app) or program executed by user device **120**. User device **120** is also in communication with other devices via network **122** which can be any type of network such as a wide area network or local area network. In one embodiment, user device **120** communicates with a customer service device **124** and other devices via a network **122**, such as the Internet.

In one embodiment, information displayed by machine control indicator **106** can also be viewed by user device **120**. User device **120** can also be used to remotely interact with machine control indicator **106** in a manner similar to a user interacting directly with machine control indicator **106**. A user can also allow another user, such as a customer service representative to view information displayed by machine control indicator **106**. In one embodiment, user device **120** can act as a conduit to allow a user, such as a customer service representative, to interact with machine control indicator **106** using customer service device **124**. Customer service device, in one embodiment, is a desktop computer but can be any type of device capable of communicating with user device **120** and indicator **106**. In one embodiment, machine control indicator **106** is capable of communicating simultaneously with user device **120** and customer service device **124**. Various communications can be facilitated by machine control indicator **106**.

FIG. 2 depicts one embodiment in which machine control indicator 202 is in communication with customer service device 208 via a user device 204 and wide area network 206 (in this case, the internet). A customer service representative can use customer service device 208 running a remote access program to connect through wide area network 206 and user device 204 to allow data to be transferred from machine control indicator 202 to customer service device 208 and back. The transfer of information can be used to provide capabilities including remote cab control, menu setup setting transfer, other record transfer, etc.

FIG. 3 depicts one embodiment in which machine control indicator 302 communicates with a customer service device 310 via a customer's local network. As shown in FIG. 3, machine control indicator 302 is in communication with customer's desktop computer 306 via the customer's wireless device 304 (e.g., a Wi-Fi router). Customer's desktop computer 306 is in communication with customer service device 310 via network 308 (e.g., the internet). In this embodiment, a customer service person can use customer service device 208 running a remote access program to connect to machine control indicator 302 through wide area network 308, customer's desktop computer 306, and customer's wireless device 304 to allow data to be transferred from machine control indicator 302 to customer service device 310 and back. The transfer of information can be used to provide capabilities including remote cab control, menu setup setting transfer, other record transfer, etc.

FIG. 4 depicts one embodiment in which machine control indicator 402 communicates with customer service device 410 via customer's computer 404 (e.g., a laptop), customer's wireless device 406 and wide area network 408 (e.g., the internet). Customer's computer 404 communicates with machine control indicator 402 and transmits information received from machine control indicator 402 to customer service device 410. Customer's computer 404 also transmits information from customer service device 410 to machine control indicator 402. The transfer of information can be used to provide capabilities including remote cab control, menu setup setting transfer, other record transfer, etc.

The wireless capability of the machine control indicator allows a user with a user device to stand in the general vicinity of the indicator and communicate with the indicator. This wireless capability allows a user to move around a machine associated with the machine control indicator and still view information from the indicator as well as control the indicator. As such, a user can perform various tasks without the need to be within reach of the indicator. In one embodiment, a customer service device can receive information directly from an indicator or via a user device. Various configurations which allow a customer service representative to view and/or modify indicator settings and information or a user to view and/or modify indicator settings are possible using one of the embodiments shown in FIGS. 1 through 4.

In one embodiment, a machine control indicator (e.g., 106, 202, 302, or 402) is provided with wireless circuitry internally mounted. In one embodiment, wireless circuitry is added to a machine control indicator in the form of an external add on device. Such an external device, in one embodiment is connected to the machine control indicator via a wired connection, such as a wired connection to a serial port. In one embodiment, a J905 connector, or other connector, is added to machine control indicator to allow the machine control indicator to be connected to other devices using, for example, an external radio module (ERM) or serial cable. In one embodiment, an internal diagnostic cable

is located inside a machine control indicator that allows connection to other devices using, for example, an ERM or serial cable. In one embodiment, an internal diagnostic connection point (e.g., a header) is located inside each machine control indicator that allows connection to other devices using, for example, an ERM or serial cable.

Returning to FIG. 1, communication among machine control indicator 106, user device 120, and customer service device 124 facilitates multiple operations as follows.

Communication facilitates bi-directional transfer of indicator calibration and menu settings to and through the application (referred to as an "app") operating on user device 120. This allows service centers to connect to the indicator to backup and/or change the indicator's menu settings remotely. The indicator's menu settings can be transferred to and stored on the app to create a backup on the app device, to e-mail the settings to a customer service center for review, to transfer revised settings e-mailed from a customer service center through the app to the indicator, and/or allow data located on the app to be accessible to e-mail and other apps.

In one embodiment, information provided by an indicator can be viewed remotely using various devices. In one embodiment, "cab control" allows a user to view indicator information and interact with an indicator remotely. For example, a device facilitating cab control can be located in a cab of front loader 104 shown in FIG. 1. Cab control allows a user in the cab of front loader 104 to see how much of an ingredient has been added to mixer 102 as the user is operating front loader 104 and may not be in viewing range of an indicator associated with mixer 102.

Communication also facilitates real-time cab control via customer service device 124. This provides a customer service representative with the ability to interact with the indicator remotely in a manner similar to how a user can interact directly with the indicator. This allows a remote customer service representative to see everything a local cab control app screen is displaying on a user device. It also allows the service center to operate the indicator remotely (e.g., push keys, read the display, change menu settings, etc.). It also allows the service center to observe how a customer is running the indicator.

Communication also facilitates cab control via user device 120. This allows user device 120 to interact with the indicator remotely (e.g., push buttons, read the display, change calibration and menu settings, etc.) via an app running on user device 120. It should be noted that real-time cab control via customer service device 124 and via user device 120 can occur simultaneously.

Communication also facilitates a rotation counter and/or timer on the app. A rotation counter and/or timer provides a user with a timer countdown display and alarm activation functionality to allow the operator to take the user device with them and leave the mixing area to perform other tasks until the mix finishes.

Communication also facilitates an hour meter. An hour meter value can be displayed on the app. An hour meter value can be transferred to the app to allow additional maintenance messages to be displayed in accordance with OEM recommendations. In one embodiment, maintenance messages can be edited on the app. Editing can include editing of the message text to be displayed on the app and the number of hours at which the message is to be activated. In one embodiment messages are displayed via a pop-up box with the message and a button such as "OK" or "Clear"

which requires a response from a user. Hour meter value information can be transferred to and/or from a service center.

Communication facilitates display of rotations per minute (RPM) history and/or analysis. FIG. 5 depicts graph 500 of a mixing profile according to one embodiment. Graph 500 depicts an RPM profile of how a user has been running their machine which can aid in determining if the user is mixing correctly. In one embodiment, mixing profile data is captured as follows.

Section A depicts data captured for each mixer load. Data is collected for the entire feed cycle including loading the mixer with ingredients, mixing the ingredients (mix time) and unloading of the mixer. In one embodiment, data is captured for at least the last 50 loads.

Starting point 502 is when the gross weight meets or exceeds the "Mix Log Start Point Weight" menu setting (default 300 lbs.) and pulses are being detected for the Rotation Counter (meaning the mix auger is rotating). The data logged for each mixer load at the "Start Point", in one embodiment, includes:

- i. Current Gross Weight (should be near 0 lbs/kgs—6 number).
- ii. Current Rotation Counter value (1234—Last 4 values of the Mixometer).
- iii. Current RPM value (1234—four numbers).
- iv. CurrentTime (14:15:46—6 character date and 24 hour clock with seconds)
- v. CurrentDate (17MR15).
- vi. Mix Load Number (123—Automatically increases for each load and should rollover from 999 to 001.)

Example Data:

```

                10      20      30      40      50
1234567890123456789012345678901234567890123456789012
Start -> "000000, 2150, 0018, 14:10:05, 05FE08, 001"
          i    ii   iii   iv   v    vi
    
```

Mid-Point 504 is when the gross weight decreases by the new "Mix Log Mid-Point Weight Tolerance" Menu setting (default 300 lbs.) This is to determine when the user has finished the loading/mixing process and is starting to unload the mixer. For example, a user adds and mixes feed ingredients up to mid-point 504. At mid-point 504, a discharge door or gate of the mixer is opened so that the feed can be discharged from the feed mixer for access by animals, such as livestock. A user may need to move the feed mixer around an area in order to discharge feed at various locations. As shown in FIG. 5, after mid-point 504, the weight of feed measured decreases as the feed mixer is emptied. The speed of the feed mixer is detected and recorded during the time the feed mixer is discharged. The method also supports shutting the mix auger OFF, pausing, and back ON again during the loading process. If the Rotation Counter stops seeing pulses (i.e. they have turned OFF the mix auger), the "Total Mix Time" is paused and then continues to accumulate the "Total Mix Time" when Rotation Counter pulses begin again. The mix auger must be rotating to unload a feed mixer, so rotation counter pulses should be seen while unloading the 300 lbs. The data logged for mid-point 504, in one embodiment, includes:

- vii. Current Gross Weight.
- viii. Current Rotation Counter value (1234—Last 4 values of the Mixometer). This will be used to determine the number of rotation counts between the starting point and the mid-point—Mixer Loading Rotation Duration Counts (XXXX).
- ix. Current RPM value (1234—four numbers).
- x. Mixer Loading Duration Time (HH:MM:SS)—this is the length of time between the starting point and the mid-point.
- xi. Current value entered/stored for the Rotation Counter key.
- xii. If batching: The total amount loaded identified by the batching code.
- i. Current Gross Weight (should be near 0 lbs/kgs—6 number).
- ii. Current Rotation Counter value (1234—Last 4 values of the Mixometer).
- iii. Current RPM value (1234—four numbers).
- iv. CurrentTime (14:15:46—6 character date and 24 hour clock with seconds)
- v. Current Date (17MR15).
- vi. Mix Load Number (123—Auto increases for each load and should rollover from 999 to 001.)

Example Data:

```

                10      20      30      40      50
1234567890123456789012345678901234567890123456789012
Mid -> "024150, 2175, 0024, 00:14:25, 000025, 024150"
          vii  viii  ix   x    xi   xii
    
```

Stop Point 506 is when the gross weight decreases into the Zero/Balance point+the new "Mix Log Start Point Weight" described previously. The method also supports shutting the mix auger OFF, pausing and back ON again during the unloading process. If the Rotation Counter stops seeing pulses (i.e. they have turned OFF the mix auger), the "Total Mix Time" is paused and then continues to accumulate the "Total Mix Time" when Rotation Counter pulses begin again. The mix auger must be rotating to unload a feed mixer, so rotation counter pulses should be seen while unloading the 300 lbs.

The data logged for each mixer load at the "Stop Point", in one embodiment, includes:

- xiii. Current Gross Weight (should be near 0 lbs/kgs).
- xiv. Current Rotation Counter value (Mixometer).
- xv. Current RPM value (1234—four numbers).
- xvi. Mixer Unloading Duration Time (HH:MM:SS)—this is the length of time between the mid-point and the stop point.
- xvii. Total Time (includes seconds) while loading and mixing (stops when the operator starts the unloading process).
- xviii. Current Time (14:15:46—6 character date and 24 hour clock with seconds)
- xix. Current Date (17MR15).

Example Data:

```

                10      20      30      40      50
1234567890123456789012345678901234567890123456789012
End -> "000000, 2195, 0010, 00:08:10, 00:22:35, 14:33:35, 05FE08"
          xiii  xiv  xv   xvi  xvii  xvii  xix
    
```


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The data can also be combined as shown below:
Example of all Three Sets of Data:

```

          10      20      30      40      50
1234567890123456789012345678901234567890123456789012
Start -> "000000, 2150, 0018, 14:10:05, 05FE08, 001"
Mid -> "024150, 2175, 0024, 00:14:25, 000025, 024150"
End -> "000000, 2195, 0010, 00:08:10, 00:22:35, 14:33:35, 05FE08"

```

FIG. 6 depicts mixing profile **500** from FIG. 5 and also includes mixing log **600**. In one embodiment, data is captured every X number of seconds (e.g., 1-999, with a default of 15). This interval can be identified by a user via a menu setting. The timer interval is selected to provide enough detail to create a chart showing how a feed mixer was used. In one embodiment, such data is captured for each mixer load. The data can be collected for the entire feeding cycle including loading the mixer with ingredients, mixing the ingredients (mix time), and unloading the mixer. Data is stored when a user pauses the mixing cycle (i.e., no rotation pulses). In one embodiment, data is recorded for at least the last 50 loads.

Rotation pulse data (i.e., RPM) is saved beginning at starting point **502**. The data logged for each mixer load at start point **502** includes:

- i. Once per load: Mix Load Number (123—Automatically increases for each load and should rollover from 999 to 001.)
- ii. Once per load: Mix Log Time Interval Seconds (123)
- iii. Current Gross Weight (should be near 0 lbs/kgs).
- iv. Current RPM value (1234—four numbers).

Example Data:

```

          10      20      30      40      50
1234567890123456789012345678901234567890123456789012
Start -> "001, 015, 000010, 0015, 000120, 0015, 000240, 0015 . . ."
          i   ii  iii   iv   iii  iv   iii  iv . . .

```

Data capture and storage for the mix log ends at stop point **506**.

FIG. 7 depicts Hours/RPM graph **700** which shows hours a machine has been run at various RPMs. Mixers and other equipment typically have optimal speeds. Recording speed information allows an OEM to know how an end user is using a piece of equipment, such as a mixer. In addition, recorded speed information allows an OEM to determine if changes are required to better use the equipment (i.e., mix ingredients better). Because applications may vary, a flexible way to capture RPM is provided. Some examples of possible menu settings include:

- v. Capture every hour for RPM's from 0-99 RPM's.
 1. RPM History Low Starting Point=0.
 2. RPM History Low Resolution=1.
 3. RPM History High Starting Point=50.
 4. RPM History High Resolution=1.
- vi. Capture every hour for RPM's from 0-49 RPM's and also look at RPM's above 50, but at a lower resolution.
 5. RPM History Low Starting Point=0.
 6. RPM History Low Resolution=1.
 7. RPM History High Starting Point=50.
 8. RPM History High Resolution=5.
- vii. Capture every hour for RPM's from 250-350 RPM's and 950-1050 RPM's.
 9. RPM History Low Starting Point=250.
 10. RPM History Low Resolution=2.

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11. RPM History High Starting Point=950.

12. RPM History High Resolution=2.

In one embodiment, another method for capturing RPM includes:

viii. Add the capability to the indicator to record the amount of time that the feed mixer is running and at what RPM at two different RPM's.

13. Allow a maximum of 50 data points (each) The data point value should support numbers up to 999,999, 999 (ulong is fine) to provide enough history.

14. Add Menu Settings to the indicator to tailor how these data points are used:

a. RPM History Low Starting Point (default=0).

b. RPM History Low Resolution (default=1).

c. RPM History High Starting Point (default=50).

d. RPM History High Resolution (default=1).

ix. Allow these Menu Settings to be set remotely (by the App or serially).

x. Allow the data points to be reset remotely to 0 (by the App or serially). This clears ALL data points, not on an individual basis.

15. Nice to Have—separate resets for Low and High history.

xi. Nice to Have—Use the “Low Starting point” to record ALL of the hours for any RPM's at or below that RPM.

xii. Nice to Have—Use the last RPM data point of the “High Starting point” to record ALL of the hours for any RPM's at or above that RPM.

All of the data described above can be captured by a machine control head and various sensors. The data can be transferred to a customer service center for remote viewing and analysis.

Returning to FIG. 1, communication between machine control indicator **106**, user device **120** and customer service device **124** also facilitates display of current machine RPM. This allows a user and a customer service representative to see how the user is currently operating a machine, such as a feed mixer.

Communication also facilitates viewing of peak weight transfers in order to determine possible equipment abuse issues. In one embodiment, peak weight transfer information is only available to a customer service representative and not a user.

Communication also facilitates transmission of data pertaining to user input to a machine control indicator. In one embodiment, key presses reflecting a user interacting with a machine control indicator are recorded and can be transmitted to a customer service representative for viewing and analysis. This information can help a customer service representative understand how a user is interacting with the machine control indicator.

Communication also facilitates transmission of current alarm status information on a cab control app. In one embodiment, the current alarm status allows a user to know when to shut off a machine, such as an auger, when away from the scale while loading ingredients from bins, tanks, and/or silos.

Communication facilitates bi-directional transfer of total mixed rations (TMR) tracker feedline batching feedlines. Total mixed rations, in one embodiment, are recipes used to produce proper feed mixes. In one embodiment, TMR information is tracked by a machine control indicator and can be retrieved and displayed by a user device and/or a

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customer service device. A customer service representative can use TMR information received from a machine control indicator to determine how a TMR recipe should be adjusted based on information from a user after examination and analysis of feed output from a mixer. A customer service representative can also transmit a new and/or modified recipe to a machine control indicator in order to correct an issue with a feed mix. The new and/or modified recipe could be created using a feed management computer program (such as TMR Tracker).

In one embodiment, machine control indicator **106** of FIG. 1 has additional sensor inputs (e.g., analog and/or digital inputs). In one embodiment, additional sensors can be used to provide data to machine control indicator **106** in order to record parameters, such as temperature, and produce alarm outputs to alert a user to certain conditions. For example, temperature sensors can be placed in machine gearboxes in order to track the temperature of gear fluid in the gearbox and provide warnings to a user as necessary. In one embodiment, warning messages and/or alarms are provided to a user when a temperature exceeds a value for a temperature parameter set via a menu setting.

In one embodiment, the machine control indicator has a menu setting which allows a user to customize an alphanumeric message, such as a warning message, to be displayed when a certain condition occurs, such as a maximum temperature being exceeded. For example, a maximum temperature being exceeded can produce a warning message, such as "HITEMP", on a display of the machine control indicator. In one embodiment, a warning message interrupts a displayed weight and the message flashes for 3 seconds. Next, a scaled sensor value is flashed for 3 seconds before the indicator returns to displaying a weight. The displaying of warning messages and scaled sensor values can be repeated, in one embodiment, every minute, until the input goes below the maximum setting.

In one embodiment, a menu selection of the machine control indicator allows a user to indicate that an alarm light is to be activated when a maximum setting has been reached. For example, a user can set an alarm light to illuminate when a maximum temperature has been met and/or exceeded.

In one embodiment, a menu selection of the machine control indicator allows a user to indicate when an alarm (such as an audible alarm) is to be output. For example, a user can set an alarm to be output when a maximum temperature has been met and/or exceeded.

In one embodiment, the machine control indicator includes a menu setting which allows a user to calibrate and/or scale sensor inputs. In one embodiment, a selection offered by the machine control indicator allows a sensor value to be displayed on a large display such as a six character LCD.

Machine control indicator **106**, in one embodiment, can store sensor values. For example, the last 5 peak scaled sensor reading can be stored. In one embodiment, values to be stored per sensor input include: a scaled sensor value (i.e., gear box 1 temperature—1234), time (14:10:05), Date (05FE08), and elapsed time over the "maximum setting" value (HHH:MM:SS). This data can be transferred to a customer service device and/or to a web-server for storage and later viewing. Scaled sensor reading, such as temperatures) can be included in both Section A-mixing details (shown in FIG. 5) and Section B-Mixing log (shown in FIG. 6).

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Example of Updated Section A Data:

```

          10      20      30      40      50
5      123456789012345678901234567890123456789012
Start -> "000000, 2150, 0018, 0070, 0000, 14:10:05, 05FE08, 0001"
Mid -> "024150, 2175, 0024, 0120, 0000, 00:14:25, 000025, 024150"
End -> "000000, 2195, 0010, 0100, 0000, 00:08:10, 00:22:35, 14:33:35,
          05FE08"
10

```

With respect to Section B data, the data for the mixing log is saved beginning at the starting point described in Section A. The data to be logged for each mixer load at start point **502** includes:

- iv. Once per load: Mix Load Number (123—Automatically increases for each load and should rollover from 999 to 001.)
- v. Once per load: Mix Log Time Interval Seconds (123)
- vi. Once per load: Maximum Sensor 1 Setting (1234)
- vii. Once per load: Maximum Sensor 2 Setting (1234)
- viii. Current Gross Weight (should be near 0 lbs/kgs).
- ix. Current RPM value (1234—four numbers).
- x. Current Scaled Sensor 1 value (1234—four numbers).
- xi. Current Scaled Sensor 2 value (1234—four numbers).

Repeat v until "stop point".

A data stream including the data above, according to one embodiment, is as follows:

Example Data:

```

          10      20      30      40      50
35      123456789012345678901234567890123456789012
Start -> "001, 015, 0150, 0150, 000010, 0015, 0070, 000, . . ."
          i  ii  iii  iv   v   vi  vii  viii, repeat . . .

```

In one embodiment, data storage ends for the mix log at stop point **506** shown in FIGS. 5 and 6.

FIG. 8 depicts a flow chart of a method **800** of operation of a machine control indicator **106**. In one embodiment, the method utilizes a mobile agricultural weighing system to monitor and store ancillary operational data for diagnostic purposes on trailed and truck mounted equipment. At step **802**, operational parameters of a second machine (e.g. feed mixer **102** of FIG. 1) operationally associated with a first machine (e.g. tractor **100**) are monitored. The monitoring, in one embodiment, is performed by the machine control indicator **106** (shown in FIG. 1) located on a first machine (such as tractor **100** shown in FIG. 1). At step **804**, each of the operational parameters are associated with a common clock of the machine control indicator. The common clock allows various parameters to be tracked using the common clock so that they can be compared with to one another based on time of occurrence. At step **806**, the operational parameters are stored in a memory of the machine control indicator with a date and time stamp based on the common clock. At step **808**, the operational parameters are transmitted, along with the date and time stamp, to a user device (e.g., user device **120**) separate from the first machine and the second machine. In one embodiment, the operational parameters comprise one or more of a weight value, a rotation value, a revolutions per minute value, a peak weight value, a gearbox temperature value, and a hydraulic pressure value. The operational parameters, in one embodiment, are received from sensors located on the second machine. For

example, a feed mixer trailed behind a tractor can be fitted with various sensor that send data to the machine control indicator located in tractor.

At step **810**, data is received from the user device pertaining to operation of one of the first machine or the second machine. For example, the data can pertain to operation of tractor **100** or feed mixer **102** shown in FIG. **1**. At step **812**, actuators associated with one of the first machine and the second machine are actuated based on data received from the user device. For example, depending on the configuration of tractor **100**, one or more operations such as engine speed, steering, and/or drive speed (e.g., operations controlled from within the cab of tractor **100**) can be controlled using data received from the user device. In one embodiment, the monitoring comprises receiving data from sensors located on one of the first machine and the second machine. The second machine, in one embodiment, trails the first machine and can comprise one of a seed tender, a planter, a seed drill, an air seeder, a grain cart, and a feed mixer. In one embodiment, the operational parameters are transmitted to a customer service device from the user device.

Machine control indicator **106** of FIG. **1**, machine control indicators shown in other figures, and other components can be implemented using a computer. A high-level block diagram of such a computer is illustrated in FIG. **9**. Computer **902** contains a processor **904** which controls the overall operation of the computer **902** by executing computer program instructions which define such operation. The computer program instructions may be stored in a storage device **912**, or other computer readable medium (e.g., magnetic disk, CD ROM, etc.), and loaded into memory **910** when execution of the computer program instructions is desired. Thus, the method steps of FIG. **8** can be defined by the computer program instructions stored in the memory **910** and/or storage **912** and controlled by the processor **904** executing the computer program instructions. For example, the computer program instructions can be implemented as computer executable code programmed by one skilled in the art to perform an algorithm defined by the method steps of FIG. **8**. Accordingly, by executing the computer program instructions, the processor **904** executes an algorithm defined by the method steps of FIG. **8**. The computer **902** also includes one or more network interfaces **906** for communicating with other devices via a network. The computer **902** also includes input/output devices **908** that enable user interaction with the computer **902** (e.g., display, keyboard, mouse, speakers, buttons, etc.) One skilled in the art will recognize that an implementation of an actual computer could contain other components as well, and that FIG. **9** is a high level representation of some of the components of such a computer for illustrative purposes.

The foregoing Detailed Description is to be understood as being in every respect illustrative and exemplary, but not restrictive, and the scope of the inventive concept disclosed herein is not to be determined from the Detailed Description, but rather from the claims as interpreted according to the full breadth permitted by the patent laws. It is to be understood that the embodiments shown and described herein are only illustrative of the principles of the inventive concept and that various modifications may be implemented by those skilled in the art without departing from the scope and spirit of the inventive concept. Those skilled in the art could implement various other feature combinations without departing from the scope and spirit of the inventive concept.

The invention claimed is:

1. A method of operation of a machine control indicator located on a first machine and associated with operation of the first machine, the method comprising:

5 monitoring operator interaction with the machine control indicator;
 monitoring first operational parameters of the first machine, the first operational parameters received directly from sensors located on the first machine;
 10 monitoring second operational parameters of a second machine operationally associated with the first machine, the second operational parameters received directly from sensors located on the second machine;
 associating each of the first operational parameters received directly from the sensors located on the first machine with a date and time stamp based on a clock of the machine control indicator;
 associating each of the second operational parameters received directly from sensors of the second machine with a date and time stamp based on the clock of the machine control indicator;
 20 storing the first operational parameters and the second operational parameters in a memory of the machine control indicator with their associated date and time stamps;
 storing operator interaction information in the memory of the machine control indicator;
 transmitting the operational parameters along with their associated date and time stamps to an electronic device separate from the first machine and the second machine;
 transmitting the operator interaction information to the electronic device;
 receiving data from the electronic device pertaining to operation of one of the first machine and the second machine; and
 35 controlling actuators associated with one of the first machine or the second machine based on the data from the electronic device.

2. The method of claim **1**, wherein the second operational parameters comprise one or more of a weight value, a rotation value, a revolutions per minute value, a peak weight value, a gearbox temperature value, and a hydraulic pressure value.

3. The method of claim **1**, wherein the second machine trails the first machine, the second machine comprising one of a seed tender, a planter, a seed drill, an air seeder, a grain cart, and a feed mixer.

4. The method of claim **1**, further comprising:

transmitting the first operational parameters and the second operational parameters to a customer service device via the electronic device.

5. An apparatus comprising:

a processor; and

55 a memory to store computer program instructions for operation of a machine control indicator located on a first machine and associated with operation of the first machine, the computer program instructions when executed on the processor cause the processor to perform operations comprising:

60 monitoring operator interaction with the machine control indicator;
 monitoring first operational parameters of the first machine the first operational parameters received directly from sensors located on the first machine;
 monitoring second operational parameters of a second machine operationally associated with the first

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machine, the second operational parameters received directly from sensors located on the second machine; associating each of the first operational parameters received directly from the sensors located on the first machine with a date and time stamp based on a clock of the machine control indicator; 5
 associating each of the second operational parameters received directly from sensors of the second machine with a date and time stamp based on the clock of the machine control indicator; 10
 storing the first operational parameters and the second operational parameters in a memory of the machine control indicator with their associated date and time stamps;
 storing operator interaction information in the memory of the machine control indicator; 15
 transmitting the operational parameters along with their associated date and time stamps to an electronic device separate from the first machine and the second machine;
 transmitting the operator interaction information to the electronic device;
 receiving data from the electronic device pertaining to operation of one of the first machine and the second machine; and
 controlling actuators associated with one of the first machine or the second machine based on the data from the electronic device.

6. The apparatus of claim 5, wherein the second operational parameters comprise one or more of a weight value, a rotation value, a revolutions per minute value, a peak weight value, a gearbox temperature value, and a hydraulic pressure value. 30

7. The apparatus of claim 5, wherein the second machine trails the first machine, the second machine comprising one of a seed tender, a planter, a seed drill, an air seeder, a grain cart, and a feed mixer. 35

8. The apparatus of claim 5, the operations further comprising:

transmitting the first operational parameters and the second operational parameters to a customer service device via the electronic device. 40

9. A computer readable medium storing computer program instructions for operation of a machine control indicator located on a first machine and associated with operation of the first machine, which, when executed on a processor, cause the processor to perform operations comprising: 45

monitoring operator interaction with the machine control indicator; 50

monitoring first operational parameters of the first machine, the machine control indicator associated with operation of the first machine, the first operational parameters received directly from sensors located on the first machine; 55

monitoring second operational parameters of a second machine operationally associated with the first machine, the second operational parameters received directly from sensors located on the second machine; 60

associating each of the first operational parameters received directly from the sensors located on the first machine with a date and time stamp based on a clock of the machine control indicator; 65

associating each of the second operational parameters received directly from sensors of the second machine with a date and time stamp based on the clock of the machine control indicator;

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storing the first operational parameters and the second operational parameters in a memory of the machine control indicator with their associated date and time stamps;

storing operator interaction information in the memory of the machine control indicator;

transmitting the operational parameters along with their associated date and time stamps to an electronic device separate from the first machine and the second machine;

transmitting the operator interaction information to the electronic device;

receiving data from the electronic device pertaining to operation of one of the first machine and the second machine; and

controlling actuators associated with one of the first machine or the second machine based on the data from the electronic device.

10. The computer readable medium of claim 9, wherein the second operational parameters comprise one or more of a weight value, a rotation value, a revolutions per minute value, a peak weight value, a gearbox temperature value, and a hydraulic pressure value. 20

11. The computer readable medium of claim 9, wherein the second machine trails the first machine, the second machine comprising one of a seed tender, a planter, a seed drill, an air seeder, a grain cart, and a feed mixer. 25

12. A method of operation of a machine control indicator for a tractor associated with operation of the tractor, the method comprising: 30

monitoring operator interaction with the machine control indicator;

monitoring first operational parameters of the tractor, the first operational parameters received directly from sensors located on the tractor;

monitoring second operational parameters of a trailer attached to the tractor, the second operational parameters relating to a feed mixer associated with the trailer, the second operational parameters received directly from sensors located on the trailer;

associating each of the first operational parameters received directly from sensors located on the tractor with a date and time stamp based on a clock of the machine control indicator;

associating each of the second operational parameters received directly from sensors located on the trailer with a date and time stamp based on the clock of the machine control indicator;

storing the first operational parameters and the second operational parameters in a memory of the machine control indicator with their associated date and time stamps;

storing operator interaction information in the memory of the machine control indicator;

transmitting the operational parameters along with their associated date and time stamps to an electronic device separate from the tractor and the trailer;

transmitting the operator interaction information to the electronic device;

receiving data from the electronic device pertaining to operation of one of the tractor and the trailer; and

controlling actuators associated with one of the tractor or the trailer based on the data from the electronic device.

13. The method of claim 12, wherein the trailer comprises a feed mixer, the second operational parameters comprising a weight value pertaining to a weight of feed in the feed mixer, a rotation value indicating whether an auger of the

feed mixer is rotating, a revolutions per minute value
identifying a speed the auger is spinning, a peak weight
value identifying a peak weight of feed in the feed mixer, a
gearbox temperature value identifying a temperature of fluid
in a gearbox of the feed mixer, and a hydraulic pressure 5
value identifying a pressure of the fluid in the gearbox.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 10,421,050 B2
APPLICATION NO. : 15/158778
DATED : September 24, 2019
INVENTOR(S) : Jerome A. Bump, Jack Allen Danner and Christopher V. Horton

Page 1 of 1

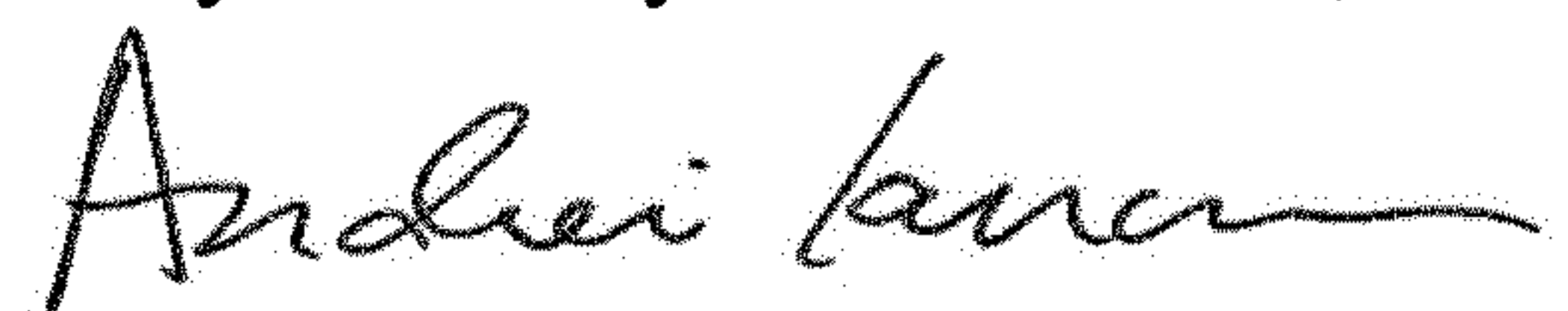
It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Specification

Column 1, Line 9, "Application No. 61/165,547" should read --Application No. 62/165,547--

Column 14, Line 27, "Repeat v until "stop point"." should read --Repeat v-viii until "stop point".--

Signed and Sealed this
Thirty-first Day of December, 2019



Andrei Iancu
Director of the United States Patent and Trademark Office

UNITED STATES PATENT AND TRADEMARK OFFICE
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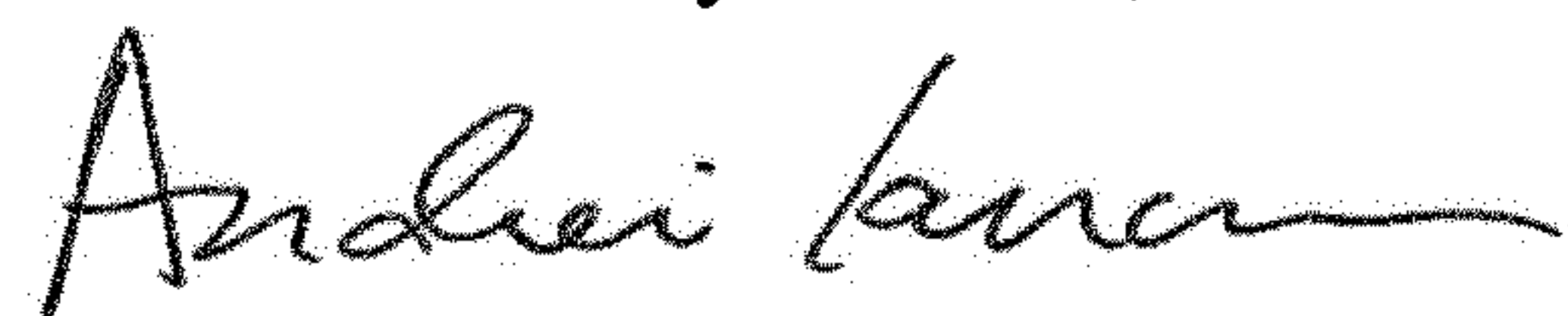
It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page:

The first or sole Notice should read --

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b)
by 299 days.

Signed and Sealed this
Second Day of June, 2020



Andrei Iancu
Director of the United States Patent and Trademark Office